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Logic and Axiomatics in the Making of Latino sine Flexione

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Résumé : Cette contribution examine l'arrière-plan scientifique de Latino sine Flexione (LSF), une langue auxiliaire internationale élaborée par Peano. Le LSF s'insère dans le cadre d'un mouvement linguistique plus vaste résultant des nouvelles technologies, lesquelles accélérèrent la mondialisation. La science constitue une force motrice dans le développement d'une langue auxiliaire internationale, étant donné qu'elle favorise les contacts internationaux et qu'elle fournit des données et des méthodes permettant de construire une telle langue. Avec le LSF, Peano entreprit de réaliser une partie du rêve leibnizien d'une langue universelle, dont une version simplifiée et provisoire du latin représenterait la première étape. Le LSF fut conçu à partir des fragments de Leibniz rassemblés par Couturat. En éliminant les traits conventionnels du latin standard, Peano entreprit de le réduire à son expression logique. Inspiré par des préoccupations similaires à celles qui furent à l'origine du symbolisme du *Formulario*, il chercha à mettre sur pied une langue simple, réduite à un noyau logique commun à toutes les langues, et de ce fait adaptée à l'usage international. Pour ce faire, Peano procéda de la manière suivante : il élimina les inflexions de tous les mots et il établit une « algèbre de la grammaire » régissant les règles de formation des mots. La simplicité, la non-redondance et la calculabilité sont les valeurs-clés du LSF inspirées de la pratique mathématique de Peano.

Abstract: This contribution examines the scientific background of Latino sine Flexione (LSF), an international auxiliary language constructed by Peano. LSF is part of a larger linguistic movement resulting from new technologies that accelerated globalisation. Science is a major driving force behind the international auxiliary language movement, both for creating an increased need for international contacts and for lending its data and methods to language construction. With LSF, Peano attempted to realize part of Leibniz's dream of a universal language, of which a temporary simplified form of Latin would become the first step. LSF was designed following Leibniz's fragments

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compiled by Couturat. By eliminating conventional features from standard Latin, Peano attempted to reduce it to its logical expression. Inspired by the same concerns that motivated the symbolism of *Formulario*, he aimed for a simple language that owed its fit for international use to its being stripped down to the logical core shared by all languages. To achieve this, Peano proceeded by eliminating inflections from all words and establishing an "algebra of grammar" that governed the rules of word-formation. Simplicity, non-redundancy and computability are key values of LSF inspired from Peano's mathematical practice.

1 Introduction

This essay is dedicated to Giuseppe Peano's work in interlinguistics, or language construction for international communication. Peano's reflections on mathematical symbolism and his pursuit of major Leibnizian ideas resulted in *Formulario* and the axiomatic theory of natural numbers that earned him his reputation in the history of mathematics and also in the construction of an international language called Latino sine Flexione (LSF), or Interlingua. This linguistic project occupied most of his later years, ensuring him an important place in the history of international auxiliary languages. In the following, we examine the philosophical background of LSF. We start with a short overview of the historical context that led to the emergence of constructed languages for international communication. Peano's involvement in the movement was boosted by his reading of Leibniz's newly discovered manuscripts and his contact with Louis Couturat. Following Leibniz's idea of a characteristica universalis, Peano separated logic from convention in language and planned LSF as a language free from conventions reigning in natural languages. The influence of Peano's mathematical thinking on LSF can be seen in its axiomatic properties of simplicity and non-redundancy, as well as in its algebraic modification of Latin.

2 The question of language in the early 20th century

International auxiliary languages (also called interlingua by Peano, or inter-language) are defined as languages constructed for communication between people with different native tongues. They appeared towards the end of the 19th century when national independence movements and rivalries grew simultaneously with cross-border commercial, administrative and scientific

contacts in Europe. The international auxiliary language (IAL) movement can be considered an intellectual product of "the first wave of globalization" that lasted from 1870 to 1914. In economic history, this period is marked by the rapid development of transportation and telecommunication technologies and a resulting increase in the circulation of goods and persons. This situation gave rise to a growing number of international bodies and an associated trend toward standardization across national borders. The International Telegraph Union was established in 1865, the Universal Postal Union in 1874 and the International Bureau of Weights and Measures in 1875. The Olympic Games were initiated in 1896 and the Nobel Prizes in 1901. From 1867 onwards world fairs began to be organized regularly. As well as the 2nd International of the workers' movement, transnational political structures were founded such as the International Federation of Free Thought (1880), the International Sionist Organization (1897), the International Bureau for Masonic Affairs (1902) and the first international positivist congress which met in 1908. Among other notable structures set up during the first wave of globalization are the Hague conferences in 1899 and 1907, the international peace congresses and several international scientific bodies [Rasmussen 2001].

IALs (or interlanguages) were suggested by many as a viable alternative to any of the existing languages belonging to a particular nation because of the increased need to cooperate in a multilingual Europe of emerging and competing national sensitivities. War resisters were among the leading supporters of such a seemingly neutral solution to the language problem. A constructed language that was nobody's property would, they expected, contribute to mutual understanding of peoples and prevent enmities. Despite general scepticism at its reception, IAL was a project with considerable backing from a good deal of scientists, including linguists. The leading interlanguages like Esperanto and its derivative Ido figured in the agendas of scientific organizations [Gordin 2015] and were far from being marginal amateur creations. IAL was discussed alongside other possible solutions to the perceived language problem in Europe such as an existing language (and possibly more than one) or the revival of a dead language (Latin). But IAL advocates advanced strong arguments against these. Firstly, the use of the language of a dominant nation would grant unfair privilege to its native speakers, whereas a neutral language would put all interlocutors on an equal footing. Therefore, a language that would be learned by everyone was thought to be an antidote to nationalism and an incentive to build a peaceful global community. Secondly because an interlanguage would be built specifically for the purpose of international communication, it would be a more efficient instrument to accomplish that function. To succeed, an interlanguage would have to be designed with the ease of learning and its expressive potential primarily in mind. The movement started with the creation of Volapük by Johann Martin Schleyer, a German priest, in 1879. Volapük was the subject of considerable but short-lived interest. In 1887, Ludwik Lejzer Zamenhof, a Russian-Jewish ophtalmologist in the multi-ethnic and multilingual city of

Bialystok, published Esperanto, an interlanguage whose community outlived its creator and which has remained active to this day. Esperanto was followed by alternatives, including those emerging from reform proposals, such as Ido, devised by the French logician and Leibniz scholar Louis Couturat to be an improvement of Esperanto. It is in this context that Peano created LSF as a Latin-based isolating language for international communication. He used this language in the 5th edition of *Formulario* and published some other mathematical papers using it.[1]

Peano maintained strong ties with the IAL movement and he had in-depth knowledge of its most important projects. In 1906 (3 years after publishing LSF), Peano attended the World Esperanto Congress in Geneva. In 1907, he took part in the meeting of the Delegation for the adoption of an international auxiliary language, set up under the leadership of Couturat following the International Congress of Philosophy (1900). This event marks the beginning of Peano's active interest in language construction which constituted his main focus in his later life. In 1908, he was elected member and director of the Akademi internasional de lingu universal (the Volapük Academy). The following year he renamed it Academia pro Interlingua, made the membership open to all and declared that each academician was free to use his own form of interlanguage—a major change from Schleyer's monopolistic attitude with Volapük which arguably alienated its supporters in the long term and hampered its adoption. Peano praised Volapük for its morphological regularity (which constitutes the main reason of its success, according to Peano) but also criticized it for its lack of internationality as its lexicon was mainly based on shortened Germanic roots:

> Each affix has a fixed meaning; the affix is added to the root without reduction. This constitutes the biggest superiority of Volapük over natural languages and explains its rapid diffusion in 1887. But the author gives the affixes values of Germanic affixes; and there is no univocal correspondence between affixes, prepositions and grammatical elements from different languages.[2] [Peano 1912, 479]

After taking over the directorship of the Academy, Peano soon turned it into a democratic platform for experimenting with IAL and then an organ of diffusion for LSF/Interlingua.

In a sense, one might consider the existence of IALs as a testimony to the capacities of modern science. Not only were they inspired by new

1. See [Kennedy 1980] for a full bibliography.

2. "Omni affixo habe sensu constante ; affixo es addito ad radice sine reductione. Hoc constitue magno superioritate de Volapük super linguas naturale, et explica suo diffusione rapido in 1887. Sed auctore da ad affixos de Volapük valore de affixos de germanico ; et non existe correspondentia univoco inter affixos, praepositiones et elementos grammaticale de linguas differente." [All translations are mine, unless otherwise indicated.]

technologies and used data from comparative linguistics, but, to some extent, they also aimed at increasing scientific literacy and sustaining a common world culture around science. For Peano, the *de facto* internationality of scientific terminology shows the path to the internationalism desired in other areas. For this reason, a scientific vocabulary common to all (or most) European languages forms the core of LSF/Interlingua vocabulary. Internationalization through the progressive expansion of scientific vocabulary to other contexts also has a secondary pedagogic effect of familiarizing the lay public with the language of science. For Peano, Interlingua would be intelligible to scientifically literate Europeans with virtually no effort required. Those not familiar with scientific jargon could acquire this knowledge through learning and using Interlingua which is a positive side effect of this linguistic project:

> Every cultured person who knows either Latin vocabulary or the scientific vocabulary of a European language understands Interlingua without studying it. Through Interlingua a less cultured person acquires Latin vocabulary which is living within his own language and becomes cultured.[3] [Peano 1927, 501]

Although the major influence came from mathematics and linguistics, scientists from other disciplines engaged in the IAL activism in the first half of the 20th century, notably Richard Lorenz, Leopold Pfaundler and Wilhelm Ostwald, who contributed with Couturat and Jespersen to a volume entitled *International Language and Science* in 1910 [Couturat, Jespersen *et al.* 1910]. A decade later, the question of an international language for science figured in the agenda of the British Association for the Advancement of Science (BAAS). The possibility of an international auxiliary language for scientific publications was discussed at the 1921 meeting of the International Research Council in Brussels. A committee was appointed by the BAAS "to investigate and report to it [council] the present status and possible outlook of the general problem of an international auxiliary language" [British Association for the Advancement of Science 1921, 390]. The question is discussed in the 89th report of the BAAS, with a detailed examination of concurring solutions to the problem of international communication, namely Latin, English, Esperanto and Ido. The question of an IAL is introduced in terms of finding ways to ensure peace. The committee's assessment of the respective merits and weaknesses of all the above options led to its preference for a constructed language such as Esperanto and Ido ("Esperanto and Ido are suitable: but the Committee is not prepared to decide between them" [British Association for the Advancement of Science 1921, 401]) to be adopted as the IAL:

> From the evidence laid before it, the Committee (Professor Ripman dissenting) has come to the conclusion that a language

3. "Omne homine culto, que cognosce aut vocabulario latino, aut vocabulario scientifico de unu lingua de Europa, intellige Interlingua, sine studio. Homine minus culto disce, in Interlingua, vocabulos latino vivente in suo lingua, et fi culto."

> of the type of Esperanto and Ido should be adopted as the International Auxiliary Language; and also, that, whatever language be adopted, it should be placed under scientific control. [British Association for the Advancement of Science 1921, 401]

The report mentions LSF as a constructed language rather than as a way of internationalizing Latin, then dismisses it due to the proven success of Esperanto/Ido that was already in stable use.

For the BAAS committee, a world unified by unprecedented developments in transportation and telecommunication technologies needs another linguistic technology to complement this ongoing globalization process:

> It is a truism that modern science has revolutionised the material conditions of our existence and that, in particular, the development of means of inter-communication—railway, steamship, telegraph—has added to the amenities of life; but, unfortunately, opportunities for strife have increased almost *pari passu* and what is now required is some means of attaining greater mutual knowledge as an insurance against future conflicts and misunderstandings. Experimental science has forged the wheels of civilised life; can humanistic science provide a lubricant to make them run more smoothly? [British Association for the Advancement of Science 1921, 390]

Indeed, arguments from technology and historical development are prominent in the IAL movement, which often portrayed itself as a logical product of its times.[4] IAL advocates praised technological developments and highlighted the contrast between the material unification of the world and subsisting national divisions. For instance, Couturat and Léau insist on the necessity for language to catch up with the advancement and standardization reigning in other products of human civilization.[5] This distance between perceived levels of material and intellectual advancement is also used by Lorenz for the

4. Gordin notes that "[t]he common trope [in the movement] was to draw inspiration from contemporary innovations in communications and transportation technologies and the standardisations that followed in their wake" [Gordin 2015, 114].

5. "Its necessity results even more obviously from the development of means of communication: what good is being able to commute abroad in a few hours if one can neither understand the inhabitants nor make oneself understood by them? What good is being able to telegraph from a continent to another and make a phone call from a country to another if the two interlocutors do not have a common language to write or converse in?" ["Sa nécessité résulte encore plus évidemment du développement des moyens de communication : à quoi bon pouvoir se transporter en quelques heures dans un pays étranger, si l'on ne peut ni comprendre ses habitants ni se faire comprendre d'eux ? À quoi bon pouvoir télégraphier d'un continent à l'autre, et téléphoner d'un pays à l'autre, si les deux correspondants n'ont pas de langue commune dans laquelle ils puissent écrire ou converser ?"] [Couturat & Leau 1903, ix].

defence of IAL.[6] Likewise, Pfaundler situates the IAL in the continuity of the modern standardization process.[7] Through comparisons with successful accomplishments in other areas, IAL's advocates intended to mitigate prejudice against it while also putting the movement into a wider historical perspective to help it gain legitimacy.

3 Leibniz, the precursor to Interlingua

Peano's introduction to the second tome of *Formulaire de mathématiques* and his explanations elsewhere make clear that the symbolism used in *Formulario* originates in the Leibnizian idea of an ideographic writing [Peano 1896a,b, 1897]. But it is after starting his exchanges with Couturat that Peano turned to Leibniz for a solution to the problem of international communication which was much debated in his day. In 1899, Peano sent his assistant Giovanni Vacca to Hannover to study Leibniz's unpublished manuscripts. The following year, Vacca met Couturat at the first International congress of philosophy (Paris). At the time, Couturat was already working on the *Logic of Leibniz*, a monograph in which he introduced Leibniz's thoughts on universal language [Couturat 1901]. After his contact with Vacca, Couturat started an editorial project of compiling Leibniz's unpublished writings which was to be completed in 1903.[8] Peano's quotations of Leibniz in his first article on LSF [Peano 1903] are taken from this compilation by Couturat. Later, Peano collaborated with Couturat on the publication of a mathematical dictionary in 1910, in Ido, German, English, French and Italian. After fruitful contacts lasting for years, Peano and Couturat fell out, seemingly due to rivalry about IAL.[9]

As noted by Couturat [Couturat 1901], in addition to his influential characteristica universalis, the need to construct a rational grammar for the universal-language-to-come brought Leibniz to search for a provisory auxiliary idiom that would "serve as an intermediary between living languages and the

6. "We boast of our international intercourse. The civilised world has extended to new nations and has embraced whole regions of the earth and yet, in spite of the magnificent means of material communication, nothing of a similar nature has been done for the purpose of uniting minds together in an equally practical manner" [Lorenz 1910].

7. "The introduction of a common system of weights and measures was also declared to be impossible at one time, nevertheless it has since been carried out in science. The construction of a system of telegraph wires connecting the whole civilised world and a telegraph alphabet common to all nations was declared seventy years ago to be an impossibility. Now it is ancient history" [Pfaundler 1910].

8. In the preface, Couturat mentions Vacca who drew his attention to the unpublished manuscripts of Leibniz and credits Peano's school for initiating his interest in the logic of Leibniz [Couturat 1903, i].

9. See [Roero 1999], [Luciano & Roero 2005] and [Luciano 2012] for Peano's correspondence with Couturat. For Couturat's exchange with Russell on Peano, see [Russell 2001] and [Garvia 2015].

future rational language". Leibniz chose Latin as the basis of this auxiliary language. While *characteristica universalis* inspired Peano the symbolism of *Formulario*, the side project of an international language was realized through LSF. Like his predecessor, Peano turned to Latin to solve the problem of international communication because it had been the international language of science until the end of the 18th century and he considered that an interlingua based on Latin would benefit from this historical and cultural basis. Peano situates LSF in the continuity of Latin—not the high Latin of scientists but the Vulgar Latin, where cases were simplified. For Peano, the common vocabulary of European languages is also "a living document about the history of civilization". Updating Latin for contemporary use would help preserve the cultural heritage of Europe by building a common identity beyond national divisions. However Peano wanted to adapt Latin to contemporary use by "rationalizing" its grammar following the guidelines set up by Leibniz. Peano's recipe for a successful IAL is to combine international elements of vocabulary with a "minimal" grammar that leaves words identical throughout different propositional contexts. An isolating grammar helps the reader in the immediate identification of words, which are to be selected from international ones for a maximal efficiency:

> Experience proves that, by using international vocabulary and simple or no grammar, many authors write in a language that cultured people understand with almost no study.[10]
> [Peano 1930, 515]

The result was to be Latino sine Flexione.

In his first exposé of LSF, Peano lists the rules of the language with corresponding quotations from Leibniz [Peano 1903]. The text starts in Latin but Peano adopts each rule from the moment it has been stated, so that the paper ends in LSF after the incorporation of successive rules. The first rule states the defining feature of LSF that makes it different from Latin—the absence of affixes and the resulting invariability of words:

> The noun case can always be eliminated by substitution of some particle in another place.[11] (Leibniz qtd. by [Peano 1903, 439])

Following Leibniz, Peano prefers the use of standardized prepositions over variation in word endings:

> We indicate genitive with *of*, dative with *to*, ablative with *from, out of*,...[12] [Peano 1903, 440]

10. "Experientia proba quod per usu de vocabulos internationale, et grammatica simplice aut nullo, numeroso auctore scribe in lingua que homine culto intellige sine studio, aut quasi."

11. "Nominum casus semper eliminari possunt substitutis in eorum locum particulis quibusdam."

12. "Indicamus genitive cum de, dative cum ad, ablative cum ab, ex, ..."

The adoption of the SVO word order common to most European languages makes the accusative unnecessary—as long as this regular word order is respected, object and subject of a verb are sufficiently well distinguished even in the absence of an accusative marker on the object. Substantives do not vary according to the case and they will have an inflexible form generally corresponding to the ablative. This is the main principle of LSF. The second rule of LSF excludes grammatical gender:

> The distinction of gender has nothing to do with rational grammar.[13] (Leibniz qtd. by [Peano 1903, 440])

Substantives are genderless but *mas* (male) and *femina* (female) can be used with them to emphasize gender when needed. Singular and plural can be indicated by *uno* and *plure* respectively but substantives are not marked by number ("the plural seems useless in a rational language" (Leibniz qtd. by [Peano 1903, 440])).[14] Conjugation is eliminated using a similar method:

> Persons of verbs can be invariable, it suffices to change *I, you, he*, etc.[15] (Leibniz qtd. by [Peano 1903, 441])

Like the substantives, verbs are inflexible: the person is indicated by the subject *(me, te, nos...)*, the tense by adverbs of time such as *heri* [yesterday], *in passato* [in the past], *nunc* [now], *cras* [tomorrow], *in future* [in the future], etc. Participles are expressed without changing the verb ending: *laudante – qui lauda* [who praises], *laudando – dum laudo* [while praising], *laudato – qui aliquo laudo* [whom someone praises], *laudaturo – qui lauda in future* [who will praise], etc. In vocabulary building, the guiding principle is again to leave each word inflexible: *hortulo – parvo horto, Romano – de Roma, Chartaceo – ex charta [paper], animose – cum animo, amabilo – qui aliquo pote ama*, etc.

4 Logic and convention in language

For Peano, who followed the ideas in Leibniz's linguistic writings, rationalizing Latin means to remove grammatical "conventions", avoid redundancy and ambiguity, be regular and economical. LSF or Interlingua is an attempt to make Latin rational by eliminating grammatical difficulties that lack any demonstrable logical function. In designing LSF, Peano aspired to develop a language "without grammar" (in his own words) in which sentences would be formed merely by juxtaposition of vocabulary and all words would keep the same form in all contexts, as they are found in the dictionary. This led Peano to turn away from agglutinative languages and choose an isolating structure instead, like English, Chinese, or the language of mathematics ("Chinese has

13. "Discrimen generis nihil pertinet ad grammaticam rationale."
14. "Videtur pluralis inutilis in lingua rationali."
15. "Personae verborum possunt esse invariabiles, sufficit variari ego, tu, ille, etc."

no grammar. Mathematical formulas, such as $2 + 3 = 5$, are propositions without grammar.")[16] In an analytic language, parts-of-speech do not affect the form of words through modifications such as declension or conjugation. As indicated by the name LSF, the language's main novelty is the absence of inflexions. Peano's dismissal of parts-of-speech is the result of the distinction he made between universal logic and a myriad of differing, conventional grammars. To prove his point, Peano illustrates how cases can be expanded with, with an example from his native Italian language:

> Italian: *Io scrivo. Tu leggi. Noi abbiamo una lingua e due orecchi. La lingua internazionale ieri era un'utopia, domani sarà la verità.*
>
> Italian without flexions: *Io scrivere. Tu leggere. Noi avere uno lingua e dua orecchio. Lingua internazionale ieri essere utopia, domani essere verità.* [Peano 1927, 492]

This experiment in translation shows that inflections can be disposed of without affecting the intelligibility of the text:

> Such a language is as clear as a language with grammar. Therefore gender, number, articles, person, mode, verbal tense, etc. are useless.[17]

Incidentally the absolute distinction of parts-of-speech is only found in inflecting languages:

> Distinction of parts-of-speech 'substantive, adjective, verb, adverb, preposition' is relative to inflecting languages and have no logical value; therefore it is of interest to linguists only. All the resulting grammatical nomenclature is without value.[18]

Therefore, parts-of-speech do not correspond to "real" categories which need to be faithfully represented in an ideography (or, for instance, an ideographically-inspired language like LSF).

The opposition of linguistics to logic was a grounding idea in the emergence of symbolic logic, to which Peano contributed greatly. Peano's view of logic as distinct from grammar follows the Aristotelian distinction between formal and real definitions. According to that, to find out whether a property of a noun is formal or real, we can substitute it with another noun with the same meaning. If the resulting sentence conserves the same truth value, then it

16. "Lingua de Sina (China) non habe grammatica. Formulas de mathematica, quale $2 + 3 = 5$, es propositione sine grammatica" [Peano 1927, 493].

17. "Tale lingua es tam claro quam lingua cum grammatica. Resulta inutile genere, numero, articulo, persona, modo, tempore de verbo, etc." [Peano 1927, 492].

18. "Distinctione de partes de oratione 'substantivo, adjectivo, verbo, adverbio, praepositione', es relativo ad lingua cum flexiones ; et habe nullo valore logico ; hoc es ultra noto ad linguistas. Toto nomenclatura de grammatica resulta sine valore" [Peano 1927, 493].

expresses a "real" property possessed by its corresponding object; otherwise, it expresses a "formal" property belonging to the name only. For example, in the proposition "*homo es rationale*" ["man is rational"], "man", which has the same meaning as "*homo*" can replace the latter without affecting the truth value of the proposition. By contrast, "*homo* es bisyllabo" ("*homo* is disyllabic") states a property of the noun *homo*, not of the man. Referring to Max Müller (*The Science of Thought* [Müller 1887]) and Michel Bréal (*Essai de Sémantique* [Bréal 1899]), Peano points out the relativity of parts-of-speech on an interlinguistic scale. Müller said that Aristotle's categories correspond to the categories of Greek grammar (for instance, they are not relevant to Semitic languages). In English, too, the same word can be used as a verb, subjective or adjective (Peano's example is "I ink a pen, I pen a word, I word a thing."). Therefore, substantive, verb, etc., are only *formal* properties of words, not *real* ones.

> The result of the fact that grammatical categories are relative to Greek and its affiliated languages and not to all languages is that this classification is formal. A property of a word is *real* (of the *thing*) if it is about the object or idea indicated by the word, it is *formal* (of the *form*) if it is about the word that indicates an idea.[19]

Following this distinction, Peano criticizes Esperanto for taking syntactic categories for granted. In Esperanto, word endings are standardized according to the part-of-speech (POS). All words are roots, to which a POS-marker is added: all substantives end with –o, adjectives with –a, adverbs with –e. Conjugation is also regular: the –i ending marks the infinitive, –as the present tense, –is the past tense, –os the future tense, –u the imperative, –us the conditional. Zamenhof built the entire Esperanto grammar around the parts-of-speech distinction. He eliminated all cases but retained the accusative for a flexible word order (ex: *Kato ĉasas muson* = *muson ĉasas kato*, "the cat chases the mouse"). In Esperanto, Peano appreciated the elimination of grammatical gender and of the personal marking by verbs. He considered this an improvement over natural languages. Yet, for him, Zamenhof did not go far enough in rationalization because he maintained parts-of-speech (although in a more systematic way than in natural languages). In Peano's view, as a merely formal property of words, POS-markers do not have a place in a rational language. Like Couturat, who criticized Esperanto's derivational system for failing to meet the logical criteria of univocity and reversibility [Couturat 1910], Peano saw objective (therefore, truly neutral) grounds for an IAL and a solid reason for its universal acceptance in universal logic. Both separated universal logic from conventional languages, associating the former

19. "Ex facto que categorias grammaticale es relativo ad graeco, et linguas affine, et non ad omni lingua, resulta que isto classificatione es formale. Proprietate de vocabulo es reale, de re, si tracta de objecto aut idea indicato ab vocabulo, es formale, de forma, si tracta de forma de vocabulo, que indica idea" [Peano 1912, 459].

with the unity needed for a successful IAL and the latter with the diversity responsible for the language barriers dividing peoples of the world. Under Leibniz's influence, both privileged logic over linguistics and both insisted on making the IAL conform to the requirements of logic.

5 The influence of mathematics

Mathematicians first debated IAL at the International congress of philosophy in 1900. Couturat was in the organizing committee. He brought up the topic during the event, then pioneered the Delegation for the Adoption of an International Auxiliary Language that met following on from the congress. The Delegation was formed as a self-appointed dedicated body to settle the international language problem by engaging experts. The philosophy congress was followed by the congress of mathematicians, where Charles Méray suggested the adoption of Esperanto [Méray 1902, paper read by Léopold Léau]. Couturat, Léau, Charles-Ange Laisant and Alessandro Padoa (of Peano's school) were in favour of the proposal while Ernst Schröder[20] and Aleksandr Vasil'ev were against. Despite Couturat's efforts to recruit him to the cause of IAL, Bertrand Russell only expressed unenthusiastic interest in it. Couturat himself broke from the Esperanto movement after successive rejections of his reform proposal. He also ended his collaboration with Peano and both men continued to promote their own IALs.

Among mathematicians, Peano's biggest support came from Paul Mansion, who appreciated the mathematical principles of construction behind LSF and declared it to be "the real IAL of the future" ([Mansion 1904], cited by [Roero 1999, 12]). Indeed LSF's morphology had qualities that appealed to mathematicians because it had taken inspiration from axiomatics and algebra. Peano's search for simplicity, non-redundancy and computability in IAL attests to the influence that his axiomatisation of the system of natural numbers had on LSF, despite these two projects being clearly separated in his work.[21] In his attempt to purify Latin from redundancies proper to natural languages, Peano is led to eliminate inflections whenever their meaning can be clearly expressed by adjoined words. Moreover, Peano goes so far as to claim he had eliminated all grammar derived from Latin ("Grammar can be reduced to

20. In 1897, Schröder had introduced a pasigraphy of his own making for scientific purposes only, in his talk in the International Congress of Mathematicians in Zürich. See [Gray 2008], [Peckhaus 2014] and [Schröder 1898].

21. For instance, Peano associates simplicity with the practice of mathematicians: "Mathematicians generally prefer simpler forms; orators and poets prefer long and sonorous sentences." ["Mathematicos praefer in generale forma plus simplice; oratores et poetas praefer periodo longo et sonoro"] [Peano 1912, 466].

little or nothing").[22] This means paraphrasing standard Latin sentences by replacing affixes with appropriate accompanying words or prepositions.[23]

The strategy of eliminating all "useless elements" from IAL indicates a functionalist view of language that dominated the understanding of interlanguage planners. It helped them counter-object to accusations of not respecting historical languages as they are and attempting to change them in an unnatural way, without regard for their spiritual identity. For Peano, we do not owe the Latin of Cicero and Horatio respect for its traditional grammar as it is already a dead language. Using a living language "without grammar" would produce a similar effect to walking around with uncustomary clothing in public but the fact that Latin is not in public use makes it legitimate to modify it following the technical needs of international communication such as simplicity [Peano 1927, 493]. If the adjunction of fixed words in their form as found in dictionaries suffices to produce an intelligible output (and this is the case, as Peano shows with examples of translation from Latin to LSF), then this method should be preferred for its greater simplicity and thus its suitability for its purpose—easy universal use.

To some extent, Peano takes the ideographic language of algebra as a model for LSF, even though these two symbolisms do not have the same purpose. The ideographic nature of algebraic symbols makes them suitable for use in calculations.

> Algebraic equations are much shorter than their expression in ordinary language, are simpler and clearer and may be used in calculations. This is because algebraic symbols represent ideas and not words. [Peano 1915, 228]

The Peanian ideography is intended to "establish a one-to-one correspondence between ideas and symbols, a correspondence which is not found in our ordinary language" [Peano 1897, 191].

> The ideas represented by our symbols are very simple ideas and do not have exactly the value of their corresponding terms in ordinary language, which represent more complex ideas. Thus the sign ϵ may be read "is a", or "est" in Latin but represents the idea obtained from the term "est" when abstraction is made from grammatical mood, tense and person. [Peano 1897, 193]

22. "Grammatica pote es reducto ad pauco aut nihil" [Peano 1927, 484].

23. Clearly, what Peano means by grammar is the agglutinative features of Indo-European languages. Against this ethnocentric misunderstanding, Jespersen points that, technically, there is no language without grammar. Even Chinese, a model for Peano (like Leibniz and other language constructors inspired by its ideography, before him) for its analytic structure that contrasts with Indo-European languages, incorporates grammatical features through means other than desinences. [Jespersen 1928, 47–48], qtd. [Falk 1999, 64–65].

In LSF, eliminating inflections that cause word variations can be read as the linguistic counterpart of this ideographic attempt.[24]

Peano's algebraic conception of grammar for a rational language is most clearly seen in the derivation system of LSF. Talking about *Formulario*, Peano insists on the role that symbols play in rigorous reasoning and discovery of knowledge beyond their more modest function as a shorthand for more cumbersome expressions. The Leibnizian calculus ratiocinator was influential mainly in Peano's search for an appropriate symbolism for writing mathematical statements. In a similar way, Peano undertook to create an "algebra of grammar" [*algebra de grammatica*] to clean Latin from redundant suffixes and, to achieve this, established morphological equations such as the following. For example, by putting *que* before or *–nte* after a verb, one obtains an adjective. *Que*, like *–tore, –ace, –ido*, etc., turns a verb into an adjective; therefore, it belongs to the category $A - V$ [*adjectivo ex verbo*]. "$A - V$ = *que = (stude)nte = (audi)tore = (rap)ace = (val)ido = (noc)ivo = (pend)ulo = (viv)o = (med)ico*". Followed by an adjective, "es" makes a verbal construction (therefore, it is classified as $V - A$). Given that $V - A$ *(es)* and $A - V$ *(–nte)* have opposite values, they cancel each other and can be eliminated altogether for the sake of simplicity: "es $(V - A)$ stude**nte** $(A - V)$" equals "$(V - A)$ + stude + $(A - V)$", equals "stude".[25] The suffix *–tate* turns an adjective into a noun (*substantivo abstracto ex adjective*, $S - A$). The reverse $(A - S)$ is expressed by *que habe, cum, –ale, –ose*, etc. Using basic algebraic equations, Peano offers logically simpler alternatives to some words in standard Latin:

> Justitia = jus + –to + –itia = jus + $A - S + S - A$ = jus, jure.
> Porositate = poro + –oso + –itate = poro. [Peano 1912, 471]

Likewise, "habe $(V-S)$ ardore $(S-V)$" equals "arde" $((V-S)$ + arde + $(S-V)$ = 0), "habe dolore" equals "dole", "habe fervore" equals "ferve", since "habe + (–ore) = 0".[26] Together, such equations constitute "the algebra of grammar". Incidentally, according to the algebra of grammar, *ente* or *ont–* [being] has no real conceptual value ("This word is commonly used in philosophy. We can see its null value.").[27] In a similar way to Carnap's elimination of Heidegger's discourse on Being and Nothing by a logical analysis of its propositions, Peano arrives at an anti-metaphysical position against the concept of "being" through a logical analysis of derivations in Latin.

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24. "Leibniz's idea of a characteristic containing 'real' characters is not completely abandoned in Peano's perspective. It emerges with even more force in Peano's investigations into a universal language because the latino sine flexione was to be based on symbols (roots of Latin words) that should preserve the essential relation to the denoted concept, independently of grammatical variations" [Cantù 2014, 30].

25. $0 = (V - A) + (A - V)$ = es que = es –nte.

26. $0 = (V - N) + (N - V)$ = habe -ore.

27. "Isto vocabulo es de usu commune in philosophie. Nos pote vide suo valore nullo" [Peano 1912, 464].

6 Conclusion

Peano created LSF in an age of globalization that led many intellectuals to look for an alternative medium of international communication. His engagement with Leibniz's influential work in logic and his familiarity with ongoing trends in linguistics are the main influences behind LSF—a constructed language modelled on axiomatics with a lexical basis in the common cultural heritage of Europe as found in scientific terminology.

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